Climate of Maryland

Introduction

This publication consists of a narrative that describes some of the principal climatic features and a number of climatological summaries for stations in various geographic regions of the State. The detailed information presented should be sufficient for general use; however, some users may require additional information.

The National Climatic Data Center (NCDC) located in Asheville, North Carolina is authorized to perform special services for other government agencies and for private clients at the expense of the requester. The amount charged in all cases is intended to solely defray the expenses incurred by the government in satisfying such specific requests to the best of its ability. It is essential that requesters furnish the NCDC with a precise statement describing the problem so that a mutual understanding of the specifications is reached.

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The Means and Extremes of meteorological variables in the Climatography of the U.S. No.20 series are recorded by observers in the cooperative network. The Normals, Means and Extremes in the Local Climatological Data, annuals are computed from observations taken primarily at airports.

The editor of this publication expresses his thanks to those State Climatologists, who, over the years, have made significant and lasting contributions toward the development of this very useful series.

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Topographic Features- The State of Maryland extends mainly in an east-west position between longitudes 75 and 79° West, spanning a distance of 240 miles. The latitude varies from about 38 to nearly 40° North, with a latitudinal width of approximately 125 miles in eastern portions, gradually narrowing to about 1-1/2 miles in the Appalachian Mountain region near Hancock and increasing again to 35 miles at the extreme western boundary. The total area of the State is 10,460 square miles.

The Chesapeake Bay, elongated in a northerly direction, extends for about two-thirds of its length deep into Maryland. It virtually separates the State into two provinces except for a narrow neck of land about 10 miles wide in Cecil County, which bridges the gap between Chesapeake Bay and the State of Pennsylvania.

That portion of the State of Maryland east of Chesapeake Bay is commonly referred to as the "Eastern Shore". The five southernmost counties between the Potomac River and the Chesapeake Bay are commonly referred to as Southern Maryland. To the north and northwest of Southern Maryland, an area made up of six counties and located on the Piedmont, is an area commonly referred to as Northern-Central Maryland. The remainder of the State including roughly the Appalachian Mountain area or the three western counties is termed Western Maryland.

Although Maryland ranks as one of the smaller states with respect to size, it encompasses an extremely wide range of physiographic features that contribute to a comparatively wide range of climatic conditions. It extends across three well-defined physiographic belts that parallel the Atlantic Coast in varying widths from New England to Georgia. These physiographic provinces are the: Coastal Plain, Piedmont province, and Appalachian province.

The land rises more or less gradually from the Atlantic Ocean across the Coastal Plain (which virtually includes the Eastern Shore and Southern Maryland) and then more rapidly across the Piedmont Plateau (Northern-Central Maryland) and the ridges of the Appalachian Mountains and finally reaches its highest point at 3,360 feet above mean sea level on Backbone Mountain in the Allegheny Plateau of Garrett County.

There are a number of factors that control the climate of Maryland. The most important factors include: the distribution of land and water masses; mountain barriers; topographic features; semi-permanent pressure centers; prevailing winds at the surface and at upper levels; storm tracks, including tropical and extratropical cyclones; latitude; altitude; and ocean currents.

Distribution of Land and Water Masses: Since the general flow of the atmosphere in temperate latitudes is from west to east, the expansive land mass immediately to the north and west predisposes the Maryland area to a continental type of climate. This type of climate in middle

latitudes is marked by well-defined seasons. Winter is the dormant season for plant growth based on low temperatures rather than drought. In spring and fall the changeableness of the weather is a striking feature. It is occasioned by a rapid succession of warm and cold fronts associated with cyclones and anticyclones that generally move from a westerly direction. Summers are warm to hot. The higher atmospheric humidity along the Atlantic coastal area causes the summer heat to be more oppressive and the winter cold more penetrating than for drier climates of the interior of the continent.

Mountain Barriers and Topographic Features: At times in winter, the Appalachian Mountains afford a degree of protection from the icy blasts of arctic air, particularly when a high pressure area attended by a cold wave approaches from the west. The modifying influences of the mountain barrier attending the passage of a storm area from the Ohio Valley are sometimes quite marked. The warming of the air as it descends the eastern slopes of the mountains may at times exceed 10 degrees Fahrenheit (° F).

However, the mountains in some cases may tend to cause lower temperatures in the Maryland area. With a high pressure system over New England and a Low over the Ohio Valley, cold, low-level winds may travel southwestward and are held east of the mountains. Consequently, cold northeast winds are forced over Maryland and farther south. Any flow of this cold air up the eastern slopes of the mountain barrier would tend to lower air temperatures even more in Western Maryland mountain regions.

In the Piedmont, undulating surface configurations and slopes make cold air drainage an important consideration for crop growth. The cold air layer next to the ground becomes denser and flows from the ridges and higher elevations into the valleys and lower elevations. In the spring and fall it is not uncommon to find lower areas clearly frosted, while higher elevations are not affected. Sometimes, on clear, calm nights, the bottom portion of a tree or bush may be nipped while the upper portion is unaffected.

The Allegheny Mountains contribute to the higher precipitation and heavy snowfall on the Allegheny Plateau. Precipitation in the form of rain or snow is increased in storms or air masses that ascend the mountains from the Ohio Valley. At times the ascent of air masses up the slopes of the mountain barrier is the “trigger action” required to induce precipitation that falls on the Allegheny Plateau. Descending air on the leeward slopes is warmed with the effect of dissipating the clouds and forming a “rain shadow” to the east of the mountains.

Prevailing Winds at the Surface and at Upper Levels: The prevailing winds at the surface are determined by the frequency and intensity of anticyclones and cyclones that persist or move over the area. The preponderance of anticyclonic circulation over the northern portion of the continent in winter brings a high percentage of cold northwesterly winds to the Maryland area. Consequently, the prevailing winds are from the northwesterly quadrant from October through June.

This pattern changes in summer as the semi-permanent Atlantic High moves northwestward and dominates the circulation of air over the eastern United States. At this time, a flow of warm, moist air spreads over the area with winds from the southwesterly quadrant most of the time. In

summer, the northern portion of the continent is dominated by low pressure and mean storm tracks are displaced far to the north of Maryland.

Mean wind speeds at the surface vary from nine to 10 mph in summer and fall to 10 to 12 mph in winter and early spring. The highest mean speeds are associated with the frequent passages of well-developed cyclones and anticyclones, which bring the strong winds and changeable weather of early spring.

Maryland lies south of the mean position of the strong upper westerlies in winter and well to the south of the axis of the zonal westerlies in summer. The movement of cyclones and anticyclones over the Maryland area, as in other regions, is influenced to a large extent by the speed and direction of the upper level winds, which flow around the hemisphere in a wavelike pattern.

A well-developed high pressure system over New England or the St. Lawrence Valley and a well-developed low pressure system over Georgia, Tennessee or the Ohio Valley is the most favorable situation for rain in Maryland, while the reverse usually produces clear, dry weather.

Storm Tracks: Nearly all migrating cyclones and anticyclones crossing the United States travel from west to east. By far the greater number of cyclones travel in a northeastward direction in a path about 300 to 500 miles north of Maryland, but their influence extends southward to the Atlantic Coast and does affect Maryland. Storms which originate in the Gulf of Mexico, the southeastern United States or adjacent Atlantic coastal regions, frequently move northeastward or northward along the Atlantic Coast and can bring violent, destructive weather to the Maryland region. As these storms approach the Maryland area from the south, strong easterly to northeasterly winds bring widespread rains and cause higher than normal tides along the Atlantic Coast and on the west side of the Chesapeake Bay. This type of storm is commonly termed a "Nor'easter". Tropical cyclones or hurricanes that develop in the West Indies, the Caribbean or the Gulf of Mexico sometimes move into, but rarely pass entirely over the State. These systems also cause cloudy weather, heavy rains and high tides.

Latitude: The mean temperature difference of five to seven degrees between northern and southern latitudes of eastern Maryland in winter and four to five degrees in summer is largely, but not entirely, due to the variation in solar radiational heating. The increase in the annual variation of solar radiation at higher latitudes causes a greater yearly range in mean temperature, 45 degrees, in the northern portions of the State as compared to the 42° F range in the southern portions.

Altitude: Elevations that range from sea level in eastern portions to over 3,000 feet on the Allegheny Plateau have a significant effect on temperature conditions in Maryland. In general, the topography has the effect of reducing the temperature about a degree per 300 feet, particularly in summer. In winter, the mean temperature decrease with altitude averages slightly less than a degree per 300 feet. In the winter season the effect of elevation is sometimes a critical factor in determining whether the precipitation will fall in the form of rain or snow. Even in Baltimore, the elevation difference of 300 to 500 feet sometimes contributes to precipitation in the form of rain in lower portions of the city and heavy snowfall in the higher districts, due to a slight decrease in temperature with elevation.

Ocean Influence: Located along the east coast with prevailing westerly winds, the Gulf Stream and the Atlantic Ocean are only moderately effective in influencing the State's temperatures. Nevertheless, the relatively frequent easterly winds associated with cyclonic storms to the southeast bring about movement of air off the mild water and, consequently, tend to raise the normal winter temperatures and to lower the summer temperatures. Mean winter temperatures of the Coastal Plain and Piedmont Plateau sections of Maryland are approximately five degrees higher than for regions of the continental interior at the same latitude.

Within the State, the effect of the Gulf Stream and the Atlantic Ocean is to lower mean temperatures along the Atlantic coastal area by a degree or two in summer as compared to temperatures at the same latitude in the center of the Delmarva Peninsula. More specifically, average daily maximum temperatures are three to four degrees lower along the Atlantic Coast and average daily minimum temperatures are a degree or two higher than points in the central portion of the Delmarva Peninsula at the same latitude. This depression of the mean temperature in the coastal area in summer is due largely to a sea breeze, which develops as a result of pronounced surface heating of the interior portions of the peninsula. On some hot, summer days the maximum temperatures on the coast may be as much as 10 to 15° F lower than at points inland. It is this climatic feature that makes Ocean City and adjacent points a popular resort and vacation area in summer. In winter there is virtually no difference between mean temperatures at coastal and inland points at the same latitude on the Delmarva Peninsula.

Temperature- The mean annual temperature ranges from about 48 in the Garrett County area to 58° F in the lower Chesapeake Bay area. The winter climate on the Piedmont and Coastal Plain sections of Maryland is intermediate between the cold of the northeast and the mild weather of the South. Extremely cold air masses from the interior of the continent are moderated somewhat by passage over the Appalachian Mountains and in some instances by a short trajectory over the nearby ocean and bays. Weather on the Allegheny Plateau is frequently 10 to 15 degrees colder than it is in eastern portions of the State and, at times, extremely low temperatures occur in winter.

The average frost penetration ranges from about five inches or less in extreme southern portions of Maryland to more than 18 inches on the Allegheny Plateau. In extremely cold winters, maximum frost penetration may be double the average depth.

Summer is characterized by considerable warm weather including at least several hot, humid periods; however, nights are usually quite comfortable, with some exceptions. The average length of the freeze-free season, based on a minimum temperature higher than 32° F, ranges from more than 230 days in southern and central portions to fewer than 130 days on the Allegheny Plateau in Garrett County.

The extreme temperatures in Maryland range from -40 to 109° F. Such occurrences are extremely unusual and might happen only once in 75 or 100 years, on the average. Extremely high temperatures in Maryland are generally associated with dry weather and sometimes with the occurrence of droughts that occasionally reach serious proportions in some parts of the State.

On the average, temperatures of 90° F or higher occur on 15 to 25 days per year along the Atlantic Coast and along the shores of the Chesapeake Bay. Elsewhere, the range is from a maximum of 30 to 40 days in the central portions to a minimum of two to 10 days on the Allegheny Plateau. There is a tendency for 35 or more days with 90° F or higher to occur in the lower elevations around Cumberland due to the warming of air masses flowing down slope from the Allegheny Plateau.

The average number of days per year with minimum temperature of 32^{o} F or lower ranges from a maximum of 160 on the Allegheny Plateau to a minimum of near 70 in Baltimore city and 80 along the shores of the southern Chesapeake Bay area.

Precipitation- The average annual precipitation ranges from as much as 48 inches at places in the Allegheny Plateau and southern Eastern Shore area, at extreme ends of the State, to as little as 37 inches in the Cumberland area located in the "rain shadow" to the east of the Allegheny Plateau. Elsewhere over the State, the annual precipitation generally ranges between 40 and 46 inches. Distribution is quite uniform throughout the year, averaging between two and four inches each month except for a late spring and summer maximum of four to 5½ inches.

Although the heaviest precipitation occurs in the summer, this is the season when severe droughts are most frequent. Summer precipitation is less dependable and more variable than in winter. Although rainfall amounts are generally sufficient to grow good crops, the unequal distribution of summer showers and occasional dry periods at critical stages in crop development make irrigation necessary for maximum crop yields in some years. Annual precipitation deficits of over 16 inches occurred during extreme droughts of the 1930s, 1960s, and in the 1998 - 2002 period.

The seasonal increase in use of water by plants and evaporation (evapotranspiration) during the summer, together with the occurrence of a dry period, results in a rapid loss of soil moisture and contribute to the development of drought conditions.

Average annual snowfall over Maryland ranges from a minimum of eight to 10 inches along the coastal areas of the Southern Eastern Shore division to a maximum well over 80 inches in Garrett County. Actually, there is a variation in the annual average from about 35 inches to over 100 inches in this county. Between 1 July 2002 and 30 June 2003, Oakland reported a total snowfall of 155.5 inches.

Snow flurries can be reported as early as September on the Allegheny Plateau, and in October in extreme eastern portions of the State. The last snowfall in eastern portions usually occurs in April and on the Allegheny Plateau in May. Annual snowfall totals vary considerably from one year to another. Even in the warmest winters snow falls in Maryland; however, averages for a climatological division may be less than an inch for the season.

Late season snowfalls in March and April are not too common, but when they occur, they can be quite heavy. On March 13^{th}, 1993, a snowstorm dropped snowfall amounts up to 31 inches in Garrett County and 24 inches in Allegany County. Central Maryland received snowfall amounts between 12 and 16 inches from the storm. On April 3, 1915, a late season snowstorm produced

up to 15-inch accumulations on the Delmarva Peninsula. Ice storms or heavy wet snow occasionally take a heavy toll of power lines, shrubs and trees.

Thunderstorms are reported at a given station on an average of 30 days per year in eastern portions of Maryland and 40 days per year in western portions. They occur in all months of the year, but during the four month cold season from November through February an average of less than one storm per month is observed. An average of one thunderstorm per month occurs in March and October. May, June, July and August make up the thunderstorm season and include 75 to 80 percent of the thunderstorms that occur annually. July is the peak of the season with about 25 percent of the annual total number of thunderstorms. As few as 10 and as many as 50 thunderstorms have been observed in a given locality during the year. At Baltimore as few as one and as many as 16 thunderstorm days have been recorded in July.

Hail at a given station occurs on an average of one day per year in eastern portions and about two days per year in western portions. The total number of days on which hail is observed at one or more stations in Maryland averages about 10 to 15 days per year. Hail has been observed in all months of the year; however, occurrences in the 7-month period from September through March are infrequent. The number of days with hail at one or more stations increases from an average of one in April to about five in July, peak of the hail season, and then decreases to an average of three in August.

Although spring thunderstorms are much fewer in number than summer thunderstorms, they have a much greater tendency to occur with hail. Most of the hailstorms occur between 2:00 p.m. and 9:00 p.m. Severe, devastating hailstorms occur somewhere in the State about once every five years on the average. Hail risks to crops in Maryland are rather low compared to other parts of the country, except in Allegany County where hail occasionally damages apple crops.

All of the State lies in the Atlantic drainage except for a portion of Garrett County in the western end of Maryland which drains into the Ohio Basin. The largest river in the State, the Potomac, forms the southern boundary through most of its length. Many small streams and tidal estuaries drain the far eastern area into the Chesapeake Bay and the Atlantic Ocean.
Minor, or local flood damage, can be expected every year in streams above the tidewater areas. Floods do occur in all months of the year, but the greatest frequency is in late winter and spring. Snowmelt at times is a factor. Intense convectional storms in summer occasionally cause local flash floods. Storms of tropical origin passing through the area in late summer and fall produce high water and occasionally damaging floods, mostly in tidewater areas. These are due to the heavy rains or strong easterly winds accompanying the storm, or a combination of both. Flooding from tides at times extends upstream in the Potomac to the District of Columbia area. High water also results from persistent northeast winds along the coast caused by extratropical storms. Major floods in the Potomac River are relatively infrequent, occurring on an average of about once in five to 10 years.

Tornadoes occur infrequently in Maryland compared with areas such as the Great Plains. Of the ones that do occur, most are small and result in nominal losses. However, two strong tornadoes hit Central and Southern Maryland within an eight-month period in 2001 - 2002, causing loss of

life. About 20 percent of the tornadoes occur on the Eastern Shore, 25 percent in southern Maryland, 40 percent in north-central Maryland, and 15 percent in western Maryland. Approximately 70 percent of the tornadoes occur between 2:00 p.m. and 9:00 p.m. with a preponderance from 3:00 p.m. to 6:00 p.m.

Most tornadoes in Maryland tend to travel in the usual southwest to northeast direction, but a few have been reported to travel southeastward or in a southerly direction. Usually paths are not more than a few miles in length; however, 10 to 15 percent of these storms maintain paths of 20 miles or more in length.

Average relative humidity is lower in the winter and early spring, from February through April, and highest in the late summer and early fall, from August through October. At Baltimore, the relative humidity averages about 60 percent in February, March and April and about 75 percent in August, September and October.

Climate and the Economy- The climate of Maryland is a natural resource favorable for a wide range of agricultural, industrial and human activities.

Precipitation, the most important climatic resource, contributes to a water supply that is adequate for present needs. This is a vital factor since the population increase, growth of industry and expansion of farm irrigation systems are all added drains on this indispensable natural commodity. The main problem is the distribution of water in significant quantities at the time and place of demand. In the Coastal Plain the ground water is sufficient for virtually all needs; however, in the Piedmont and Appalachian Mountain areas the main water supplies are in the surface water resources and must be stored in reservoirs to maintain sustained yields during the infrequent dry periods.

Another favorable climatic factor is the temperature of the Atlantic Coast and Chesapeake Bay that contributes to a large number of summer resorts and recreational activities. Rest and recreation are both favored by the summer afternoon temperatures that are generally cooler along the shore and over the water than they are inland.